Astro 501 Midterm

This test is open notes. Answer all questions and PLEASE BE NEAT. If possible, write out the formulae before plugging in the numbers. If the questions require assumptions, state and justify them clearly! A list of physical constants is provided that may (or may not) be useful.

1. (5 pts) You are starting this test at 1:30 p.m. Eastern Standard Time on Nov 1. What right ascension is overhead?

2. At the high-luminosity region of the HR diagram, the instability strip has a thickness of about ~ 0.015 in $\log T_{\rm eff}$, and the luminosity of stars moving through the strip is proportional to their mass, i.e., $\mathcal{L} \propto \mathcal{M}^{\alpha}$, with $\alpha \approx 4$.

a) (10 pts) Suppose you measure the period of a single Cepheid in a galaxy. What would be the error associated with the absolute magnitude you would derive for the Cepheid?

b) (5 pts) If you wanted to obtain a $\sim 3\%$ distance to galaxy (i.e., determine the mean Cepheid distance modulus of $(m - M)$ to $\sim 6\%$), what is the absolute minimum number of Cepheids you would need to observe?

3. (10 pts) The Super-Kamiokande experiment is designed to detect solar neutrinos produced by the PP III branch of the proton-proton chain. The experiment finds that the PP III neutrino flux at the earth is 2×10^6 neutrinos cm^{-2} s^{-1}. If the PP III branch produces $\sim 0.01\%$ of the neutrinos emitted by the Sun, how much of discrepancy is there between observed flux and the predicted flux.

4. (10 pts) The conditions in a gas cloud of atomic hydrogen are such that it exceeds the Jeans criterion and so begins to collapse. If the gas cloud collapses adiabatically, will the cloud fragment? How about if the collapsing gas cloud radiates energy and remains roughly isothermal?

5. (10 pts) Amateur astronomers discover a new dwarf nova, and you decide to analyze the system. Studying the system is difficult, since the emission from the accretion disk outshines the light from the stars. However, using infrared spectroscopy you infer that the donar star is an M-dwarf (mass of roughly $\sim 0.5\,\mathcal{M}_{\odot}$) orbiting at about ~ 35 km s^{-1} with a period of 1.5 hours. Is the system being observe more face-on or edge-on? State your assumptions clearly.

Table of Constants

$c = 3 \times 10^{10}$ cm sec^{-1}	$k = 1.38 \times 10^{-16}$ ergs K^{-1}
$h = 6.62 \times 10^{-27}$ erg sec	$N_A = 6.02 \times 10^{23}$ atoms
$\sigma = 5.7 \times 10^{-5}$ ergs cm^{-2} K^{-1} s^{-1}	$a = 7.6 \times 10^{-15}$ ergs cm^{-3} K^{-4}
$\mathcal{M}_\odot = 2 \times 10^{33}$ g	$G = 6.67 \times 10^{-8}$ dyne cm^2 g^{-2}
$\mathcal{L}_\odot = 3.8 \times 10^{33}$ ergs s^{-1}	$Q_H = 6 \times 10^{18}$ ergs g^{-1}
$R_\odot = 7 \times 10^{10}$ cm	$m_H = 1.67 \times 10^{-24}$ gm
1 MeV $= 1.6 \times 10^{-6}$ ergs	1 A.M.U $= 1.66 \times 10^{-24}$ gm
1 A.U. $= 1.5 \times 10^{13}$ cm	1 pc $= 3.1 \times 10^{18}$ cm